Space Weather Technical Forecast

Issued on Saturday 1 February 2025 at 01:09 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1 Minor Storms likely day 1-2 (01-02 Feb) from fast winds and potential CME glance. Further M-class flares expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with three M-class flares observed, with peak flare M6.7 at 31/1406 UTC from the northeast complex of spots, between AR3976 and AR3778. These three regions form a large area of many small individual spots and a complex magnetic structure with ongoing development and interactivity. AR3976 is the largest, with numerous small spots with mature penumbra, while AR3978 has seen growth of spots to its north. AR3977 is the northernmost group within the region, however this has also seen some ongoing spot growth and development. The other regions remained small and simple.

A CME was observed leaving the Sun due to the M6.7 flare from the northeast disc. This remains under analysis for any Earth-directed component, but is most likely missing behind and to the north.

Solar Wind / Geomagnetic Activity: Solar winds showed a gradual and erratic connection to coronal hole 11. Solar wind speed, as measured by ACE at L1, was initially background 300-350 km/s, then rose from 31/1930 UTC to be slightly elevated at 420-450km/s by the end of the period. Density was below average to average. Interplanetary Magnetic Field, Bt, showed an erratic increasing trend from Moderate at 10nT to be Strong peaking at near 18nT. The north-south component, Bz, was mainly positive (northward), but with periods of negative (southward) orientation, ranging from +16nT to -10nT. Phi angle saw periods of positive (away from the Sun) and negative (towards the Sun). Geomagnetic activity was mainly quiet (Kp 0-2) but Unsettled (Kp 3) 31/2100-0000 UTC.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 was at Background. High energy electron flux (greater than 2MeV) at GOES16 was at Background. The associated 24-hour fluence persisted below the Active threshold, recording 9.1e5 integrated pfu at 01/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate expected, with further M-class flares and a slight chance of X-class flares, primarily from the regions on the northeast disc.

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Solar Wind / Geomagnetic Activity: The CME from the multi-stage filament eruption on 30/1400 UTC has been reassessed as likely giving a glancing impact on day 2 (02 Feb), although with low confidence. Otherwise fast solar winds from CH11, which Earth is currently moving into, are expected to dominate the forecast. These bringing Elevated solar winds (500-600 km/s) later day 1 and through day 2 (01-02 Feb) before easing day 3-4 (03-04 Feb). Geomagnetic activity is expected to become Unsettled to Active with a likelihood of G1 Minor storms day 1 (01 Feb). This potential continues day 2 (02 Feb) due to any potential CME glance and the ongoing fast winds, before receding days 3-4 (03-04 Feb) to be mainly Quiet to Unsettled with isolated Active intervals.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to be at background, but with a slightly increased potential of responding to any notable flares from day 2 (02 Feb) as the sunspot regions in the northeast move east across the visible disc. GOES16 high energy electron flux is expected to show a rising trend later in the period, likely reaching Moderate to High levels from day 3 (03 Feb). The corresponding 24-hour fluence is expected to remain below the Active threshold, but with an increasing trend from day 3 (03 Feb).

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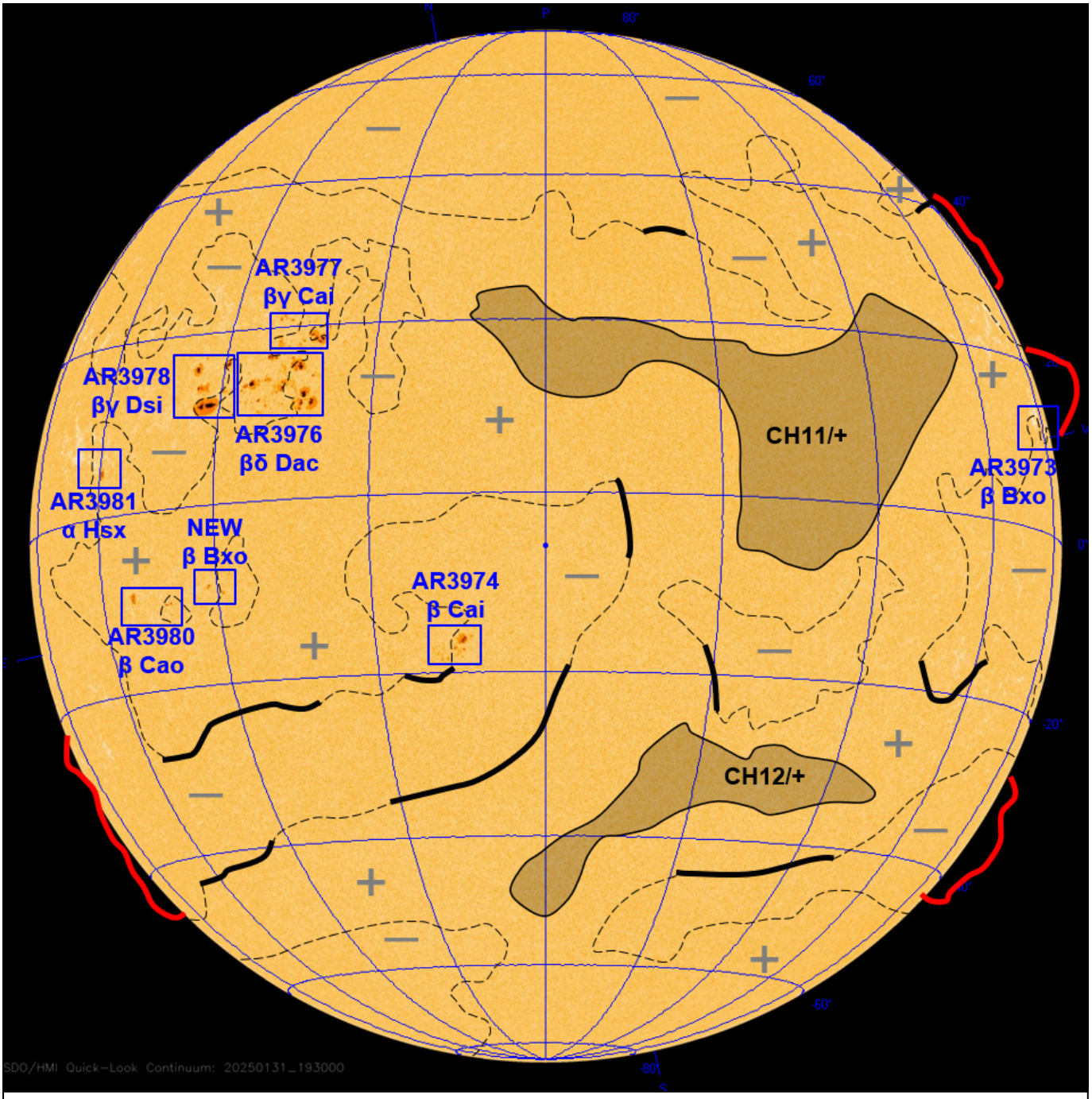
Figure 1: MOSWOC Solar Synoptic Map 31/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are two CMEs that could affect this forecast, however confidence is low. The first was from a multi-stage filament eruption off the southeast disc from around 30/1400 UTC. This has been modelled as passing mostly behind and south of Earth, however a glancing impact is possible on day 2 (02 Feb). The second CME was from the M6.7 flare of AR3976/AR3977 at 31/1406 UTC. This is still under analysis and at this stage appears likely to be missing, although a glancing impact cannot be ruled out later in the period.

Earth is currently in the process of connecting to the fast wind from CH11/+, a little later that originally expected, with solar winds now slightly elevated but expected to continue rising day 1 (01 Feb) to become elevated (500-600 km/s). While positive polarity coronal holes are unfavourable for strong connections at this time of year, the strength of the wind and the persistence of the feature which brought G1 Minor storms on the last rotation, suggest that this still could be a geoeffective feature. Furthermore, peak winds are likely to occur around the arrival of any CME glance from early on day 2 (02 Feb), before solar winds gradually ease day 3 and 4 (03-04 Feb). This is in agreement with current MOSWOC Enlil, which is now providing good guidance to expected solar winds, albeit likely over-estimated at peak.

Initially Quiet to Unsettled geomagnetic activity is expected to become Unsettled to Active with a likelihood of G1 Minor storms day 1 (01 Feb). This potential continues day 2 (02 Feb) due to any potential CME glance and the ongoing fast winds, before receding days 3-4 (03-04 Feb), to be Quiet to Unsettled with isolated Active intervals.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	40	20	5
Strong	G3	No	1	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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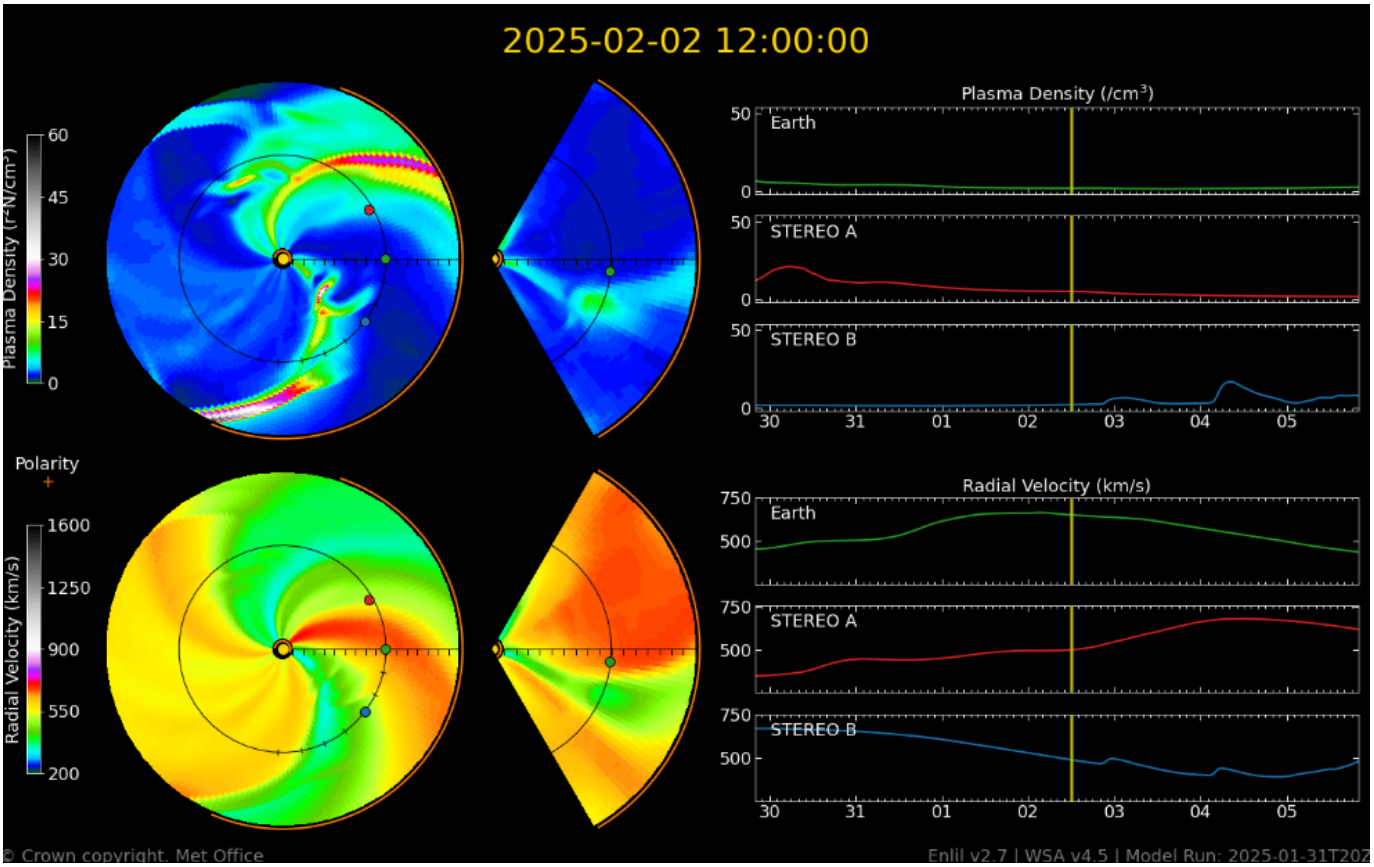
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
30/2345	Partial	Filament	29E 27S	570	02/1200 +/ 10hrs	Low confidence, glancing impact.

Figure 2: Enlil showing CH fast winds dominating, though over-estimated, along with potential CME glance to the SE



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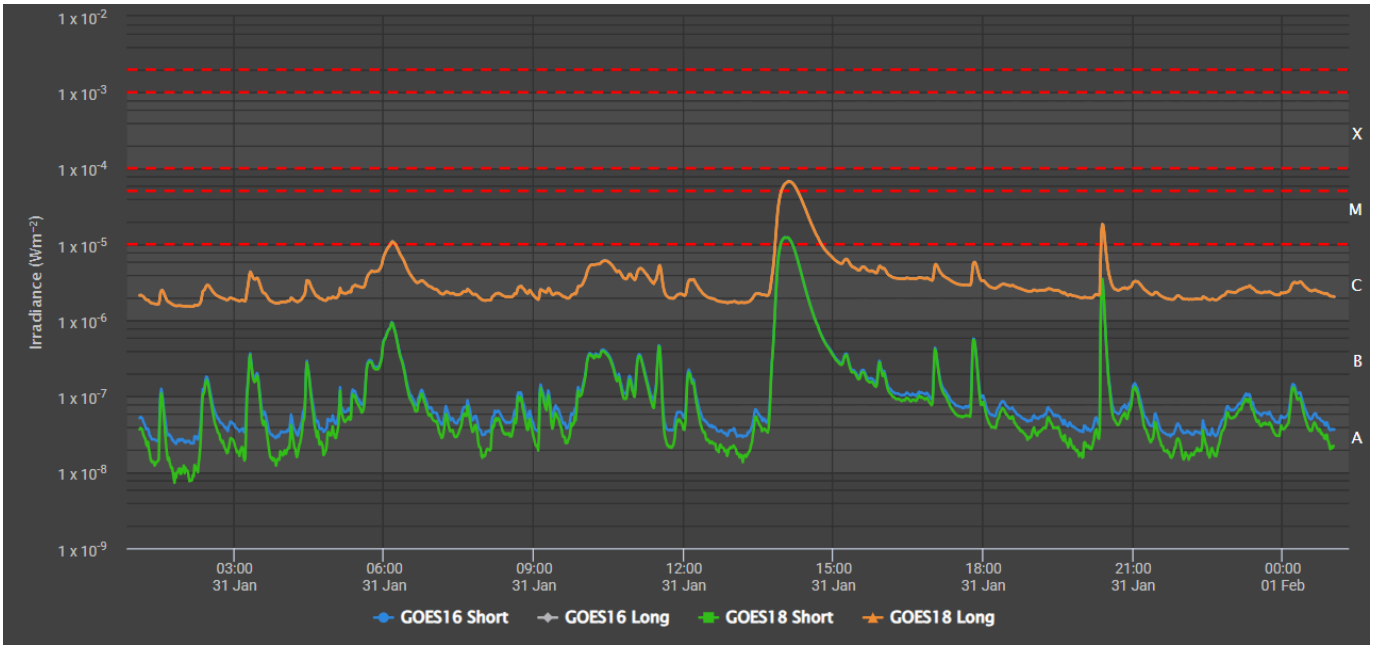
Radio Blackouts - X-Ray Flares

There are eight sunspot regions currently on the Earth-facing disc, with the majority of the activity from the large complex of small spots in the northeast. This has been analysed as three separate regions, AR3976/AR3977/AR3978, however these all show sign of interacting with each other, resulting in a broad area of magnetic complexity with ongoing flux emergence evident. The most notable of these regions is perhaps the southwestern group AR3976, due to its large number of mature spots with penumbra and the presence of weak delta spot. However, the most significant activity is from where this region connects with the eastern group AR3978. This has a more complex magnetic inversion line, and where this connection occurs there is some evidence in SDO aia-211 and aia-304 of either an internal filament or perhaps a sigmoidal-type structure. The final northwestern spot is AR3977, and while smaller, this also has a mixed polarity field with ongoing growth.

While the other regions on the disc are much smaller and simpler, with only limited growth or some decay, this complex brings a notable flare risk. Further M-class flares expected and there is an ongoing slight chance of an isolated X-class flare.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	75	75	75	75
Very Active	R3-R5 (X Class)	No	15	15	15	15

Figure 3: GOES 16-18 X-ray Irradiance



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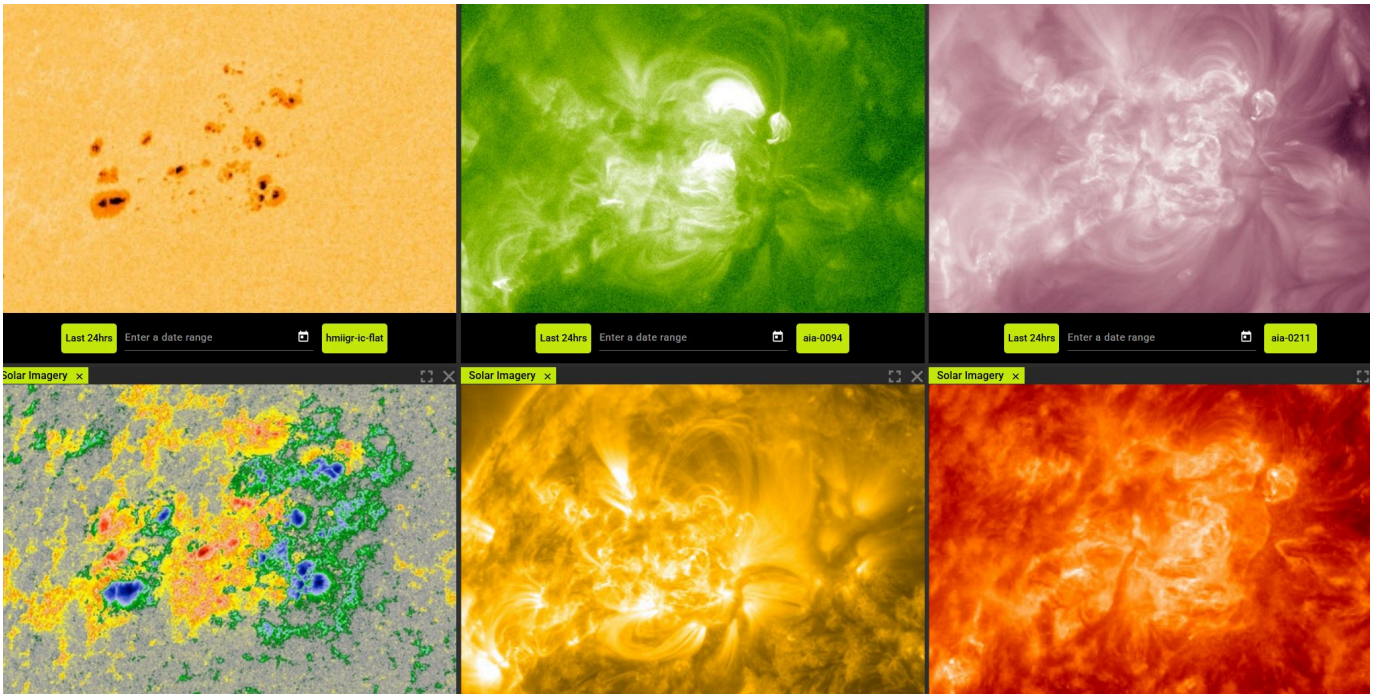
Solar Radiation Storms (High Energy Protons)

Proton flux as observed by GOES-18 is currently at background and is expected to persist at this level with the majority of the current solar activity on the northeast disc. As these regions move into the centre-disc, and then into the western hemisphere, there is a slightly increased chance of proton flux rising in response to any notable flares.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Sunspot complex on the NE disc from SDO imagery



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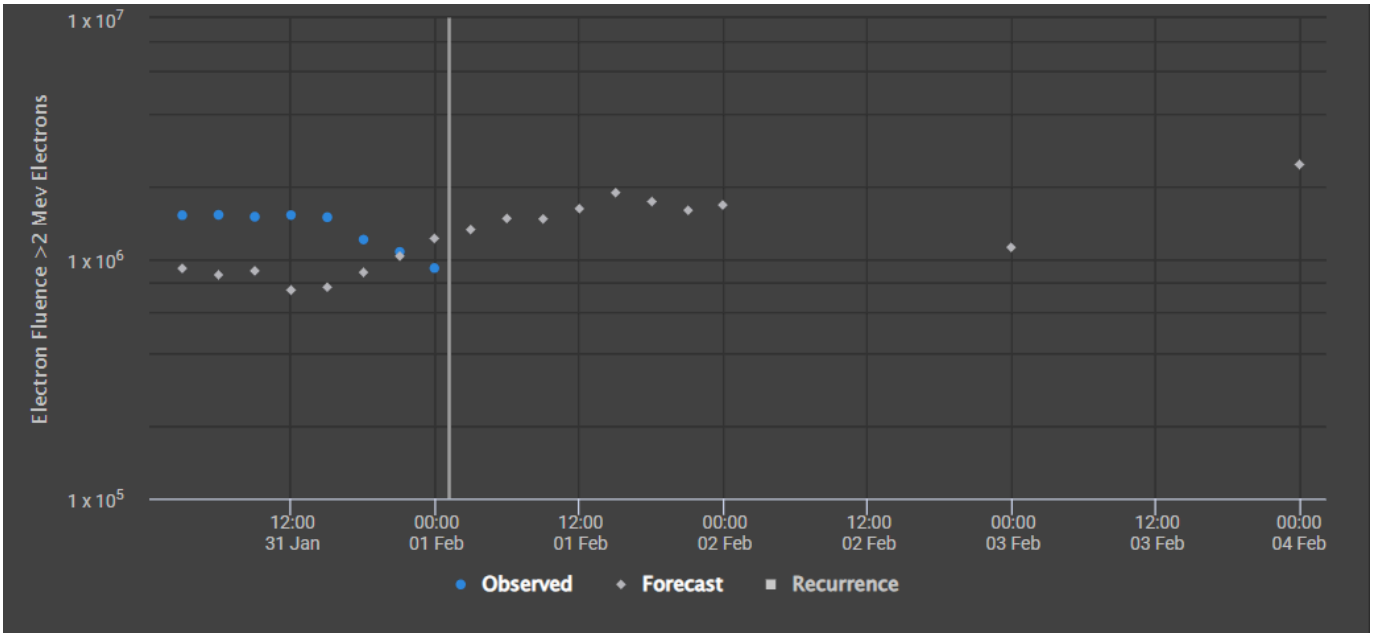
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 is currently at background. However, the onset of fast winds from CH11/+, potentially alongside any enhanced geomagnetic activity from the CME glance on day 2 (02 Feb), is expected to charge the Van Allen belts at lower orbits. As these expand outward towards GEO on day 3-4 (03-04 Feb), flux is expected to rise to Moderate with a chance of reaching High at diurnal peak.

The corresponding 24 hour fluence is expected to persist below the Active threshold day 1-3 (01-03 Feb), but with a rising trend day 3-4 (03-04 Feb), bringing a slight chance of reaching the Active level by the end of the period. REFM is currently providing good guidance for days 1-2, but currently does not capture the likely rising trend day 3.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	5	20
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

Figure 5: GOES-16 >2MeV 24 hr Electron Fluence with MOSOWC REFM.



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